

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 July 2004 (08.07.2004)

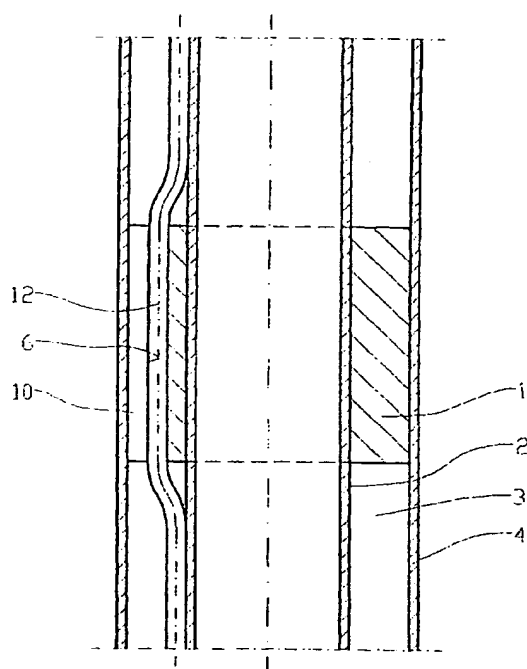
PCT

(10) International Publication Number
WO 2004/057715 A2

- (51) International Patent Classification⁷: H02G (74) Agent: HÅMSØ PATENTBYRÅ ANS; P.O. Box 171, N-4302 SANDNES (NO).
- (21) International Application Number: PCT/NO2003/000410 (81) Designated States (*national*): AE, AG, AI, AM, AT (utility model), AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, EG, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT (utility model), PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SI, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (22) International Filing Date: 9 December 2003 (09.12.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 20025911 10 December 2002 (10.12.2002) NO
- (71) Applicant and (72) Inventor: FREYER, Rune [NO/NO]; Vålendsgaten 12, N-4010 STAVANGER (NO).
- (84) Designated States (*regional*): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

(54) Title: A CABLE DUCT DEVICE IN A SWELLING PACKER



(57) Abstract: A cable duct device in a swellable packer (1) of the kind in which the packer (1) is adapted to be able of sealing an annulus (3), and in which the swellable packer (1) is provided with at least one opening (6) therethrough adapted to constitute a duct for a cable (12).

II-II

BEST AVAILABLE COPY

WO 2004/057715 A2

The term production tubing is used to illustrate the pipe enclosed by the packer. However, the packer is suitable to seal around any longitudinal body as well.

Due to technical conditions of the formation it may be necessary to provide one or more packers along the production tubing in its longitudinal extension to be able of sectioning the annulus encircling the production tubing.

According to the prior art, inflatable or mechanical expandable packers are used for this purpose. A mechanical expandable packer comprises a flexible material expanding against the casing or the walls of the formation when compressed in the axial direction of the well.

NO 20004509 discloses a swellable packer swelling in volume by the influence from the hydrocarbons of the well, whereby it is sealing against the casing or the walls of the formation.

According to prior art, it has been common to provide the packers with a cable extending through the packer and in which the cable at its end portions on the opposite sides of the packer is provided with connectors for the connection of the cable extending along the production tubing. It is obvious that the connectors of this kind may involve malfunctions, for example in the form of leakage of the pressurized fluids, bad electric contact or penetration of the formation fluids into the connectors. Thus, it is desirable to arrange whole lengths of the cable along the production tubing without having to join the cable at each packer.

US 6173788 discloses a mechanical compressible packer provided with an outer longitudinal slot in which a cable may be arranged. When the packer is compressed and squeezed against the casing, the packer material is brought to squeeze sealingly around the cable. By being situated outside of the packer the cable is relatively poorly protected during the insertion of the production tubing into the well. Obviously, the cable is also subjected to relatively great loads during the mechanical compression. The use of mechanical compressible packers has proved to be unsuitable during the sealing against a well formation as the relative expansion of the packers are insufficient.

The object of the invention is to remedy the disadvantages of the prior art.

According to the invention the object is obtained by means of the features indicated in the description below and the accompanying patent claims.

A packer enclosing a production tubing and being formed from a swellable material is provided with a longitudinal opening therethrough. The opening is adapted to constitute a cable duct. Advantageously, the through-going opening is arranged relatively close to the tubing surface outside of the production tubing. The cross section of the through-going opening may exhibit any geometrical form such as circular or oval. In its longitudinal extension the opening may be straight or have another configuration, for example S-formed or helical.

If desirable the packer may be provided with a slit protruding from the outer circumference of the packer and into the

through-going opening to facilitate placing of the cable in the through-going opening during the assembling work.

When the cable shall be arranged along the production tubing, it is unnecessary to join the cable at the packers. Thus, the
5 cable extends protected in a manner known *per se* along the production tubing and continues in a protected manner within the through-going opening in the packer to the opposite end portion of the packer, from where it again extends protected along the production tubing.

- 10 After the production tubing is displaced into the well and the swellable material has obtained contact with the swell-activating material, the volume of the packer increases, whereby the packer expands and sealingly encloses the cable and seals against casing or the formation of the well.
- 15 A non-limiting example of a preferred embodiment is described hereinafter which is illustrated in the accompanying drawing, wherein:

Fig. 1 shows in section a packer having two cables arranged therein during insertion into a casing;

- 20 Fig. 2 shows a packer having one cable arranged therein after the material of the packer has swollen sufficiently so as the packer seals around the cable and against the casing;

Fig. 3 shows a section view along I-I in Fig. 1;

Fig. 4 shows a section view along II-II in Fig. 2; and

Fig. 5 shows a section view along IIa-IIa in Fig. 2.

In the drawings the reference numeral 1 denotes a packer manufactured from a swellable material, see below. The packer 1 encircles a production tubing 2 and is adapted to be able
5 of sealing an annulus 3 between the production tubing 2 and the shell surface inside of a casing 4.

In its longitudinal extension the packer 1 is provided with an opening therethrough which is preferentially arranged relatively close to the shell surface outside of the produc-
10 tion tubing 2.

Between the cylindrical surface 8 outside of the packer 1 and the through-going opening 6 there is provided a slit 10.

A cable 12 extends through the through-going opening 6.

When the cable 12 shall be arranged along the production tubing 2, see Fig. 3, the cable 12 extends along the shell outside of the production tubing 2, in which it is covered by a protection (not showed) according to prior art.
15

At the packer 1 the cable 12 extends into the through-going opening 6, in which the material of the packer 1 protects it.
20 As the through-going opening 6 is situated close to production tubing 2, the cable 12 is relatively well protected also at the inlet and outlet of the through-going opening 6.

When the production tubing 2 along with packer 1 and cable 12 are situated in the well, the packer swells and seals the annulus 3 by contacting a swell-activating material which may
25

be of water or hydrocarbons, for example, depending on the material from which the plug is formed.

By swelling in hydrocarbons the packer 1 may be manufactured from a rubber or rubber-like material selected from the group
5 comprising EPDM, styrene-butadiene rubber, natural rubber, ethylene-propylene monomer rubber, ethylene-vinyl acetate rubber, hydrogenated acrylonitrile-butadiene rubber, acrylonitrile-butadiene rubber, isoprene rubber, chloroprene rubber and polynorbornene.

10 When water shall be the swell-material, the packer 1 may be formed according to US 4137970 disclosing a swellable material casting in which the material manufactured from hydrogen dichromat being dissolved in water is mixed into a compound of glycerol and diethylene glycol. This compound is added a
15 portion of polyacrylamide and then filled into a mould.

If desirable, the swellable material may be enclosed by a web-like material.

In an alternative embodiment the slit 10 may be situated between the through-going opening 6 and the production tubing
20 2.

In a further embodiment the packer 1 may be formed without the slit 10.

The packer 1 may be constituted by two or more segments together encircling the production tubing 2.

In Fig. 4 an embodiment is showed in which the opening 6 in its longitudinal extension is formed with a bend 14 to provide for a reduced longitudinal stiffness of the cable 12.

If desirable, at least one cable 12 may be arranged on the
5 inside of the packer (1) in a recess in the shell surface
outside of the production tubing 2.

P a t e n t c l a i m s

1. A cable duct device in a swellable packer (1) of the kind in which the packer (1) is adapted for sealing an annulus (3), c h a r a c t e r i z e d i n t h a t t h e
5 swellable packer (1) is provided with at least one through-going opening (6) adapted to constitute a duct for a cable or pipe (12).
 2. Device according to claim 1, c h a r a c t e r i z e d i n t h a t t h e t h r o u g h - g o i n g o p e n i n g (6) e n c l o s e s t h e
10 cable (12) both prior to and after the swelling has occurred in the swellable packer (1).
 3. Device according to one or more of the preceding claims, c h a r a c t e r i z e d i n t h a t i n i t s l o n g i t u d i n a l e x t e n s i o n t h e t h r o u g h - g o i n g o p e n i n g (6) m a y
15 have any configuration.
 4. Device according to one or more of the preceding claims, c h a r a c t e r i z e d i n t h a t t h e c r o s s s e c t i o n o f t h r o u g h - g o i n g o p e n i n g (6) m a y h a v e a n y c o n f i g u r a t i o n .
 - 20 5 . Device according to claim 1, c h a r a c t e r i z e d i n t h a t a c a b l e o r p i p e (1 2) i s s i t u a t e d o n t h e i n s i d e o f t h e p a c k e r (1) w i t h i n a l o n g i t u d i n a l r e c e s s i n t h e o u t e r s h e l l o f t h e p r o d u c t i o n t u b i n g (2) .
-

1/4

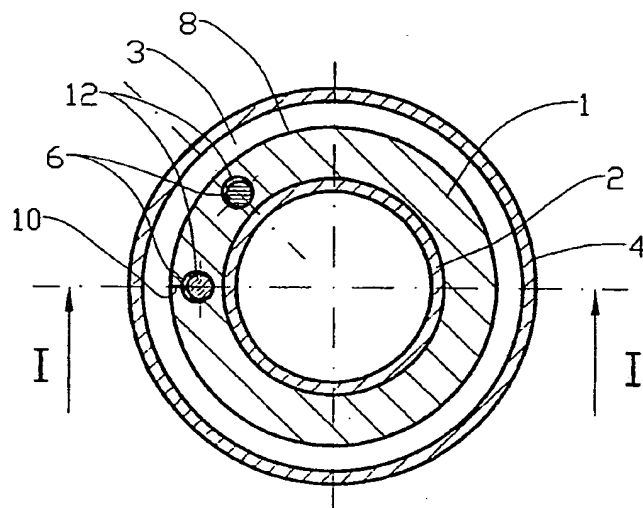


Fig. 1

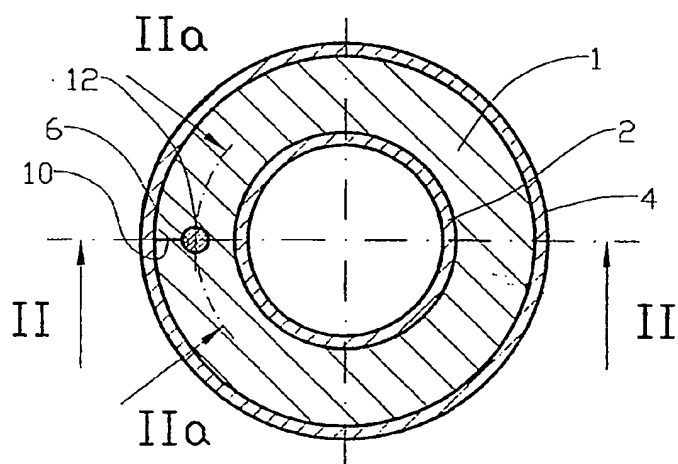
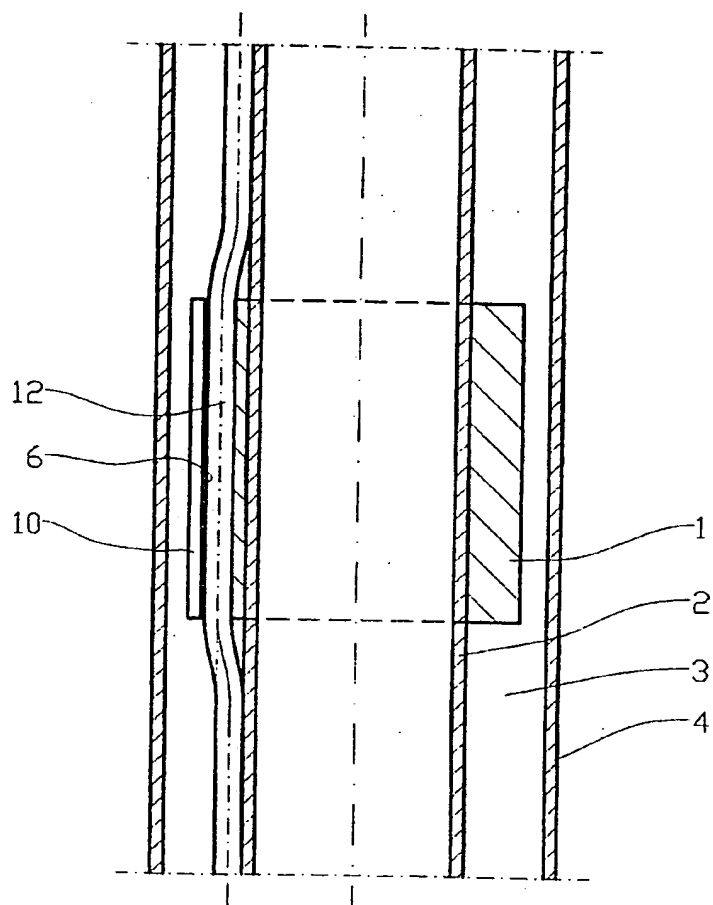


Fig. 2

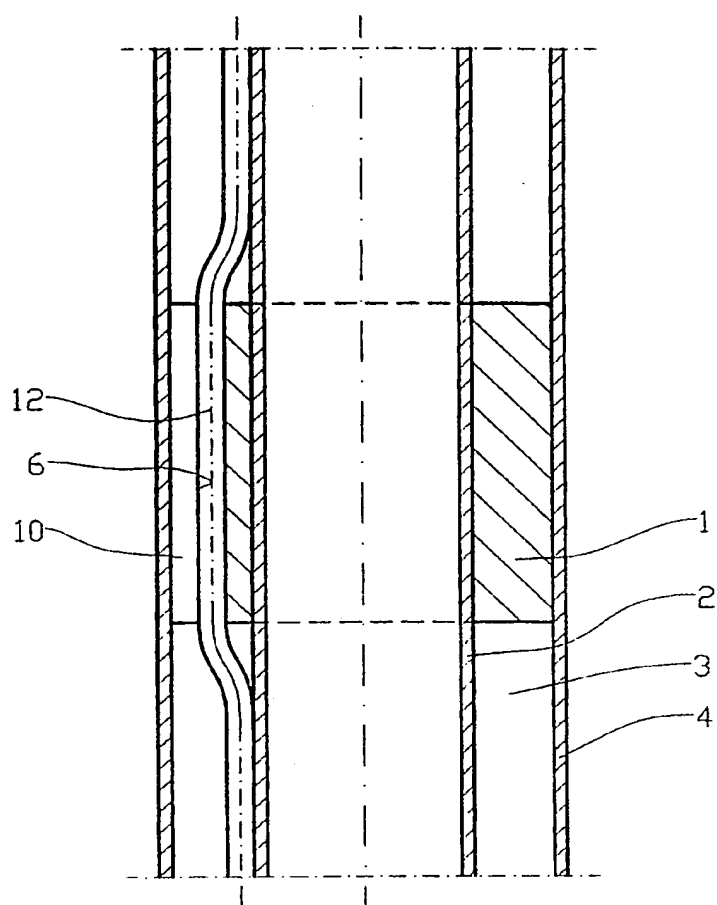
2/4



I-I

Fig. 3

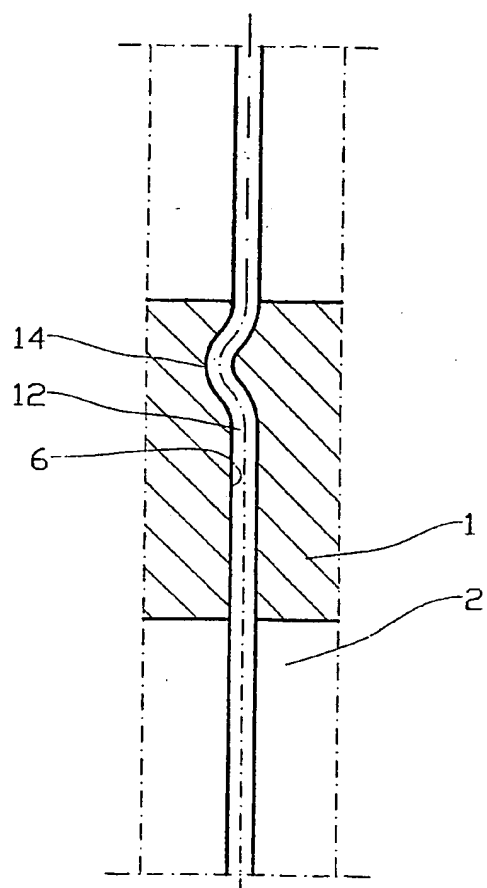
3/4



II-II

Fig. 4

4/4



IIa-IIa

Fig. 5

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☒ **BLACK BORDERS**

☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**

☐ **FADED TEXT OR DRAWING**

☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**

☐ **SKEWED/SLANTED IMAGES**

☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**

☐ **GRAY SCALE DOCUMENTS**

☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**

☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**

☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.